



Atomic Explosives

J. ROBERT OPPENHEIMER
Professor of Physics, University of California

The development of atomic weapons can, if wisely handled, make the problem of preventing war, not more hopeless, but more hopeful, than it would otherwise have been; this is so not merely because it intensifies the urgency of our hopes, but because it provides new and healthy avenues of approach to the solution of the problem

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THIS is a brief report on the future of atomic explosives. I cannot tell of the probable future technical developments of atomic explosives. When the war was over we recognized that we had only scratched the surface of this problem; no doubt since then some further progress has been made, both in development and in understanding. But these are things that we cannot talk about here. When, if ever, they can be talked about openly, it will be a very different world, and to my way of thinking a very much better one.

As for the uses of atomic explosives, the one that has been most widely discussed, the one in which their pre-eminence was first established and is most obvious, is the strategic bombardment of cities. No doubt there can be important tactical applications as well, but on these ignorance and inexperience as well as the requirements of secrecy force me to silence. There has even been a little talk of possible beneficent applications of atomic explosives, such as the blasting of polar ice and the possible control of major natural phenomena such as tornadoes, earthquakes, and eruptions. There is enough energy in atomic explosives to give these vague suggestions an air of plausibility: even the weapons so far used release about one thousandth of that in the San Francisco earthquake. But of course the forces produced by an atomic explosion have a very different sort of order from those involved in the great natural phenomena of quakes and tornadoes; and the radiation and radioactivities that accompany any major atomic explosion must at least complicate its application to benign purposes. If men are ever to speak of the benefits of atomic energy, I think these applications will at most play a very small part in what they have in mind.

There is only one future of atomic explosives that I can regard with any enthusiasm: that they should never be used in

war. Since in any major total war, such as we have known in these late years, they will most certainly be used, there is nothing modest in this hope for the future: it is that there be no such wars again.

International Authority Proposed

Some months ago, a group, acting as consultants to the Secretary of State's Committee on Atomic Energy, spent many weeks exploring this problem, which is commonly defined in a sort of code as "The International Control of Atomic Energy". Since that time our conclusions, expurgated of all secret or classified matter, have been made public, and may have come to your attention. They were made public in order to facilitate public understanding and discussion, a discussion made more necessary by the difficulty of the problem, made more difficult by the secrecy which has been maintained about many of its technical elements. What I should like to do is to add a few comments which may help to supplement the report that was made public, to make explicit some of the things left implicit in it, to restore a balance of emphasis somewhat marred by the initial accidents of its release.

The heart of our proposal was the recommendation of an International Atomic Development Authority, entrusted with the research, development, and exploitation of the peaceful applications of atomic energy, and the elimination from national armaments of atomic weapons. In this proposal we attempted to meet, and to put into a constructive context, two sets of facts, long recognized, and commonly regarded as contributing to the difficulty, if not to the insolubility, of the problem.

The first of these is that the science, the technology, and the industrial development involved in the so-called beneficial uses of atomic energy are apparently inextricably intertwined with those involved

in making atomic weapons. The same raw material, uranium, is needed for the use of atomic energy for power as for atomic bombs. The plants of an atomic power program may not be ideally suited for the production of bomb materials, but in a pinch—and atomic warfare is a pinch—they can be made to do. The various fissionable materials derived from uranium and thorium that play such a decisive part in the power program, or even in the use of atomic energy for research reactors and for advancing medicine and the practical arts, are, or can with more or less effort be made into, atomic explosives. The same physics which must be learned and studied and extended in the one field will help with the other—although there are of course some things in the higher art of bomb making that as yet appear to have no other application.

It is true that the properties that make a fissionable material useful for reactors are not quite the same properties that make it useful for bombs. Natural uranium can be used in a power plant, but I don't think a bomb can be made of it. Uranium considerably enriched in the isotope 235 can be more flexibly and effectively used in reactors; but I am not sure that it can be made explosive, and am fairly confident that it would be so ineffective as not to warrant the effort. Plutonium can be doctored—not without prohibitive cost to make it completely nonexplosive—but to make it a relatively ineffective explosive, and a difficult one to use. These differences in the requirements for controlled and explosive uses of atomic energy, might, if appropriately recognized in law, keep a group of individuals from making atomic weapons out of the materials for peacetime industry; they could retard and thus perhaps discourage nations otherwise prevented from the exploitation of atomic energy;

but to any who are actively engaged in such exploitation they could provide a deterrent so slight as to constitute a most dangerous illusion. Thus, a mere prohibition on the activities of nations in the field of atomic energy sufficiently incisive to inspire confidence that, if enforced, it would prevent rapid conversion to atomic armament, would at the same time close this field to the national exploitation of any of its benefits. This fact, which further technical developments appear unlikely to invalidate, has long been regarded as an almost decisive difficulty on the path of international control. It might have appeared so to us, too, if there had not been a greater one. For even if the course of development of atomic energy for peace were entirely distinct from its development for war, even if it were universally agreed that there were no peaceful applications of atomic energy worthy of interest or effort, we should still be faced with the fact that there exists in the world today no machinery for making effective a prohibition against the national development of atomic weapons. In the light of this fact, that to my mind touches upon the heart of the problem, the close technical parallelism and interrelation of the peaceful and the military applications of atomic energy cease to be a difficulty, and become a help. This does not, unfortunately, mean that it guarantees a solution. But it does mean that it provides a basis for seeking a healthy solution that would not otherwise exist.

If there were nothing to do with atomic energy but make bombs, there might still, it is true, be a convention between nations not to do so. Such conventions have in the past seldom withstood the strain of rivalries between nations preparing for war, nor does it seem likely that they could do so in future in the case of a weapon whose effectiveness, especially in surprise, is so spectacular. For this reason two proposals have long been current, for supplementing international conventions with some form of international action.

Difficulties of Policing

One of these would set up a scheme of multilateral or international inspection, whose sole function would be to attempt to establish that the conventions were in fact being observed. It is conceivable that if the conventions were sufficiently radical, comprising, for instance, the total renunciation of all mining and refining of uranium, such a procedure might work. But I doubt this, even in that case. I doubt whether the agency entrusted with such inspection could even then have the motivation, the personnel, the skill, the experience, or the endurance to carry out such a dreary, sterile, and repressive job. I doubt whether the relations between this agency and the nations and nationals whom it was instructed to police would be such as to diminish the nationalism leading to war, or to inspire the confidence of the

nations in each other, or to advance the cause of the unification of the world, or to serve as a useful prototype for the elimination of weapons of mass destruction, perhaps equally, perhaps more, terrible. Therefore, one may perhaps not regret that the door to this sort of international action is largely closed by the impossibility of denying to the world in any long term an opportunity to explore the beneficial possibilities of atomic energy. For once such exploration is allowed to the nations, the technical complexities and human inadequacies of international inspection as a sole safeguard become manifestly insupportable.

International Manufacture

The second suggestion for international action to supplement the renunciation by nations of atomic armaments has a more affirmative character. It is that an international agency be entrusted with the making of atomic weapons. Though there has been much in this proposal that has seemed attractive, it has two weaknesses, and probably fatal ones; the more serious is that there is nothing that an international agency can do, or should do, with such weapons. They are not police weapons. They are singularly unsuited for distinguishing between innocent and guilty or for taking even crudely into account the distinction between the guilt of individuals and that of peoples; they are themselves a supreme expression in a weapon of the concepts of total war. The second difficulty, in some sense inescapable in any form of international action, but desperately acute in this, is that such stocks of atomic weapons, however earnestly they are proclaimed international, however ingeniously they are distributed on earth, would nonetheless offer the most terrible temptation to national seizure, for the almost immediate military advantage that their use might afford.

These two examples do give recognition to the need, in any system of outlawing atomic weapons, of international action. In this I think they are sound. In fact, in another context, the study—but not the production—of atomic weapons, and inspection to prevent the illegal mining of uranium both would seem to be essential functions of an international authority.

The Problem of Control

It is time to turn to the second of the great difficulties that have from the outset been regarded as preventing any effective international control. It is the absence in the world today of any machinery adequate to provide such control, any precedent for such machinery, any adequate patterns of the past to provide such precedent. Just this is the reason why the problem is so much of a challenge, why we may be sustained by the hope that its solution would provide such precedent, such patterns, for a wider application. It did not take atomic weapons to make

wars, to make wars terrible, to make wars total. If there had never been and could never be an atomic bomb, the problem of preventing war in an age when science and technology have made it too destructive, too terrible to endure, would still be with us. There would be the blockbuster, the V-2, the M-67, and their increase; there would no doubt be biological warfare. But the atomic bomb, most spectacular of proved weapons, most inextricably intertwined with constructive developments, least fettered by private or by vested interest or long national tradition, has to many seemed the place to start.

Many have said that without world government there could be no permanent peace, that without peace there would be atomic warfare. I think one must agree with this. Many have said that there could be no outlawry of weapons and no prevention of war unless international law could apply to the citizens of nations, as federal law does to those of states, or have made manifest the fact that international control is not compatible with absolute national sovereignty. I think one must agree. Many have said that atomic energy could not be controlled if the controlling authority could be halted by a veto, as in many actions can the Security Council of the United Nations. I think one must agree with that, too. With those who argue that it would be desirable to have world government, an appropriate delegation of national sovereignty, laws applicable to individuals in all nations, it would seem most difficult to differ. With those who argue that these things are directly possible, in their full and ultimately necessary scope, it may be rather difficult to agree.

Role of the Authority

What relation does the proposal of an international Atomic Development Authority, entrusted with a far-reaching monopoly of atomic energy—what relation does this proposal of the State Department's board of consultants bear to these questions? It proposes that in the field of atomic energy there be set up a world government, that in this field there be renunciation of national sovereignty, that in this field there be no legal veto power, that in this field there be international law. How is this possible in a world of sovereign nations? There are only two ways in which this ever can be possible: one is conquest, that destroys sovereignty; the other is the partial renunciation of that sovereignty. What is here proposed is such a partial renunciation, sufficient, but not more than sufficient, for an Atomic Development Authority to come into being, to exercise its functions of development, exploitation, and control, to enable it to protect the world against the use of atomic weapons and provide it with the benefits of atomic energy.

Whatever else happens, there is likely to be a discussion of the control of atomic

energy in the United Nations Commissions set up for that purpose. Should these discussions eventuate in the proposal of an International Authority, and in a charter for that authority, these proposals and that charter would in the end be presented for ratification to the several nations. Each nation, the small as well as the great, can exercise its sovereign right to refuse such ratification. Should that happen, there would be no Atomic Development Authority, and conceivably, in my opinion probably, no trustworthy international control of atomic energy. Should a nation, after the creation of the authority, exercise its sovereign right and withdraw from it, or fail with regard to it to carry out the accepted conditions of the charter, then there will also be no Atomic Development Authority: unlike the Security Council, it presumably could not survive the application of the veto to its major provisions. But if it comes into existence, and in so far as it stays in existence, it will provide, in its field, the international sovereignty whose necessity has been so generally recognized.

Perhaps, one will say, no international enterprise can live under such conditions. But the conditions themselves will not remain unaffected by the enterprise. Its coming into existence will be a step that, once learned, can be repeated; a commit-

ment that, once made in one field, can be extended to others. If this is to happen, the development authority will have to have a healthy life of its own; it will have to flourish, to be technically strong, to be useful to mankind, to have a staff and an organization and way of life in which there is some pride, and some cause for pride. This would not be possible if there were nothing of value to do with atomic energy. This would not be possible if the prevention of atomic armament were its only concern, if all other activity was technically so separable and separate from atomic armament that it could remain in national hands. In the long struggle to find a way of reconciling national and international sovereignty, the peaceful applications of atomic energy can only be a help. It is perhaps doubtful that we should have had a federal government had not those functions that could not safely nor effectively be carried out by the states had a certain importance for the people of this country.

The Board of Consultants to the State Department was aware of the supreme necessity for providing the authority with work that could attract men, and consolidate and inspire them. It was equally aware of the complementary dangers of a too complete, a too absolute monopoly. For this reason we found it important to point out that there were many activities

in the field of atomic energy which either in themselves, or because of the ease and reliability of supervision, inspection, and control, could not lead themselves to the evasive or diversionary development of atomic weapons. In this context, but in this context only, we thought that use could be made of those differences in the requirements on fissionable materials for their use in reactors and in atomic explosives, and which we, perhaps unhappily summarized in the word denaturing. For we believed that the exploitation of these differences together with restrictions on design and operation would make it possible to operate certain types of reactors, not without international control, but without that most complete control that is an operating monopoly. I think that this will turn out to be so.

No thoughtful man can look to the future with complete assurance that the world will not again be ravaged by war, by a total war in which atomic weapons contribute their part to the ultimate wreck and attrition of our western civilization. The fact that there is so far-reaching a technical inseparability of the constructive uses of atomic energy from the destructive ones is precisely the central vital element that can make effective action possible. If we are clear on this, we shall have some guide for the future.

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Biological Phase

W. EDWARD CHAMBERLAIN

Professor of Roentgenology and Radiology, Temple University
School of Medicine, Philadelphia, Pa.

The new science of atomic energy will benefit biology and medicine not only directly, as when radioactive isotopes are put to work as tracers or as therapeutic agents, but indirectly through the advances that it will continue to produce in all scientific thinking

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FIFTY years ago, on March 1, 1896, Becquerel discovered the radioactivity of uranium. This appears to have been man's initial exploration in the field. By 1898 the Curies had discovered radium. Soon the biological implications of atomic energy became apparent through injuries to Becquerel and other workers. Evidence soon accumulated that the rays from radium, along with those from x-ray tubes, could be used with benefit in the

treatment of cancer and a number of other diseases. Thus the earliest application of atomic energy to biology lay in the field of treatment. In 1934 the Curie-Joliot's discovered artificial radioactivity. The cyclotron, already in operation in Lawrence's laboratory at Berkeley, was soon engaged in the production of radioactive isotopes of a great many of the chemical elements. Biologists were quick to see the importance of these radioactive isotopes

as "tracers" for the study of vital processes. In the meantime certain developments in the field of clinical medicine were paving the way for a very satisfying integration of the new tool into that field.

The ever-accelerating advance of science exhibits some very human facets. It even follows cycles that might be stigmatized as fashions. A good example is to be found in the influence which Sir William Osler still wields over the medical world. Osler's